OIPE IAP58
OCT 28 2005
PATENT & TRADEMARK OFFICE

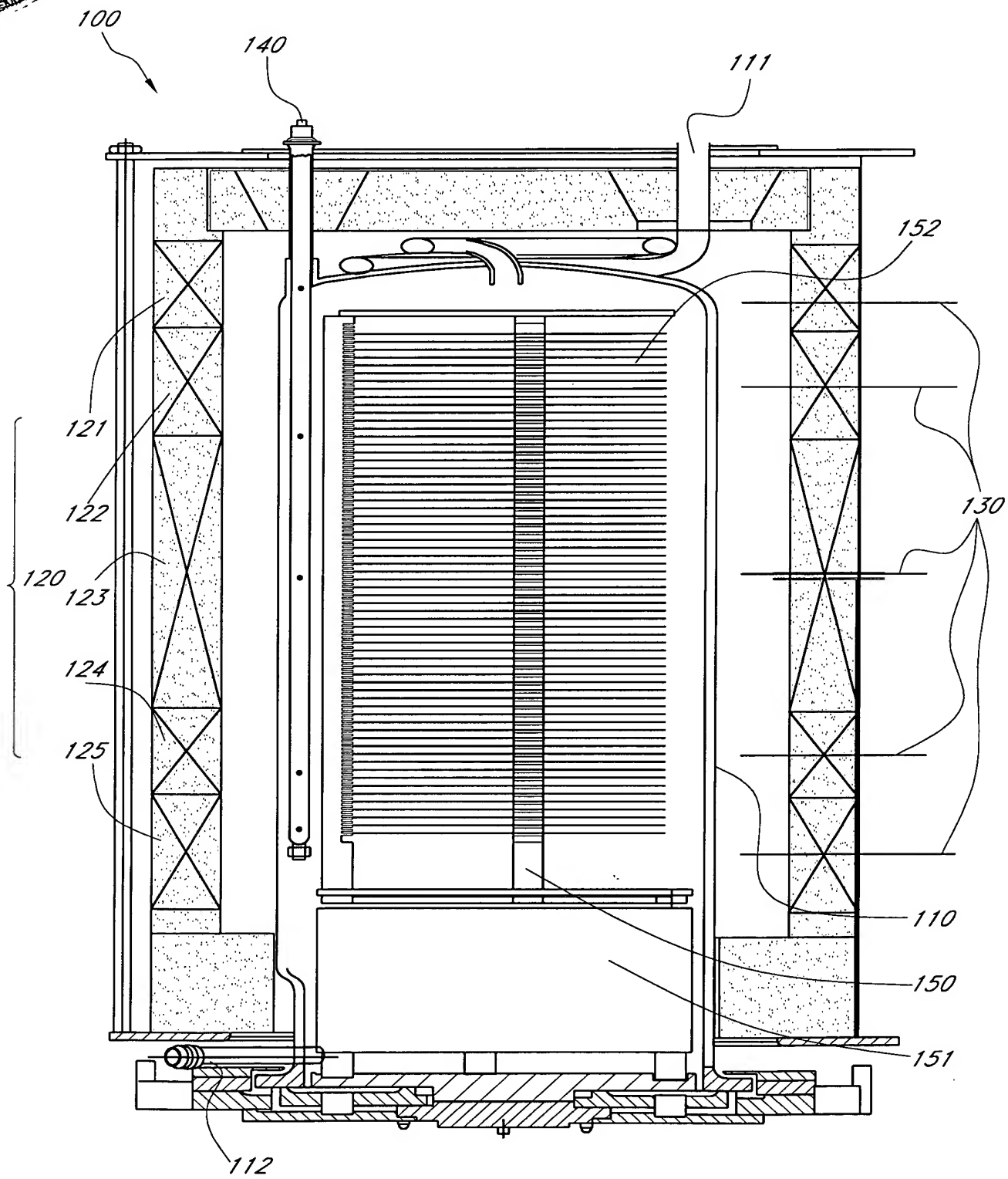


FIG. 1

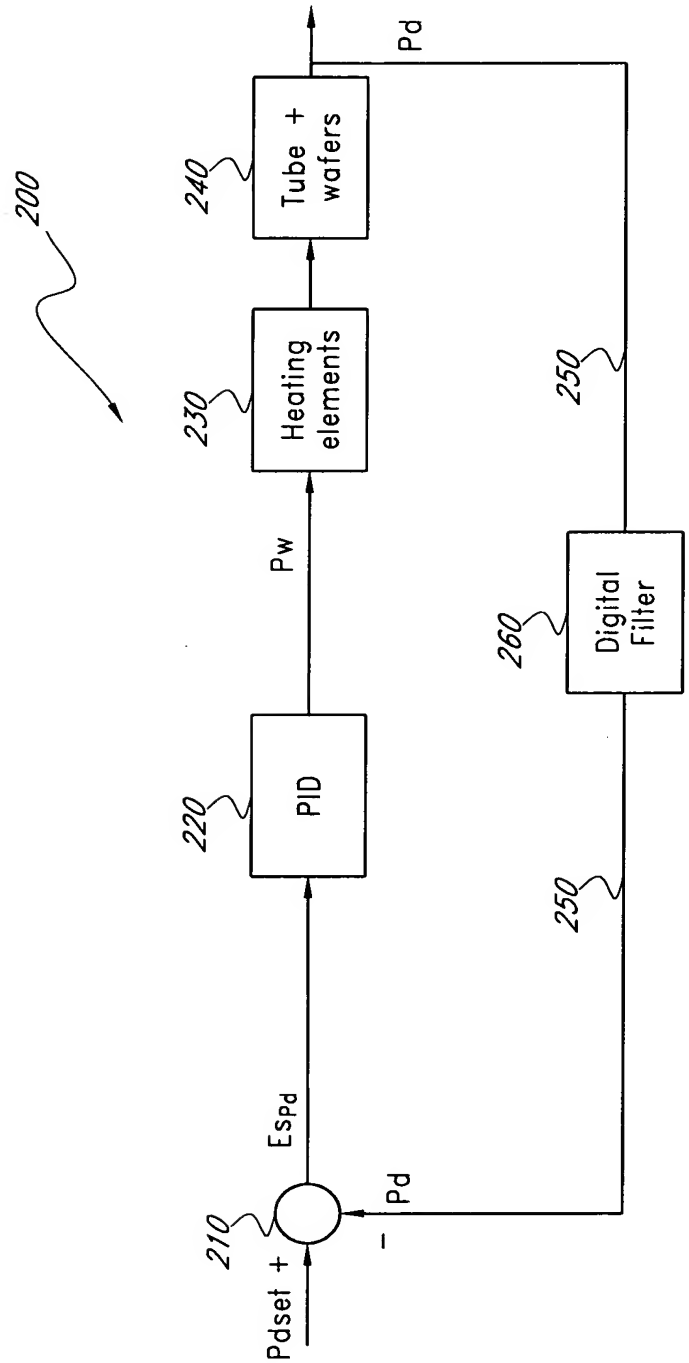


FIG. 2 PRIOR ART

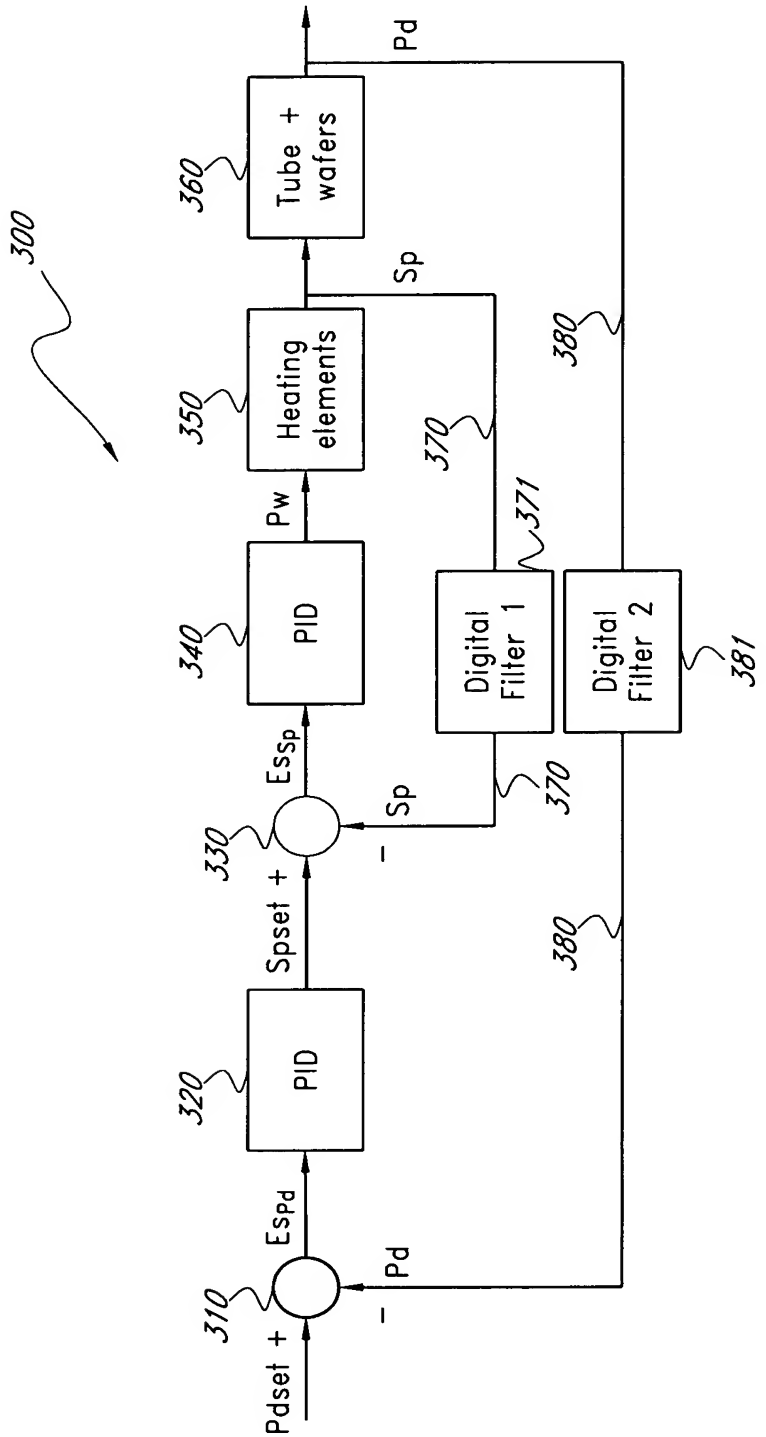


FIG. 3 PRIOR ART

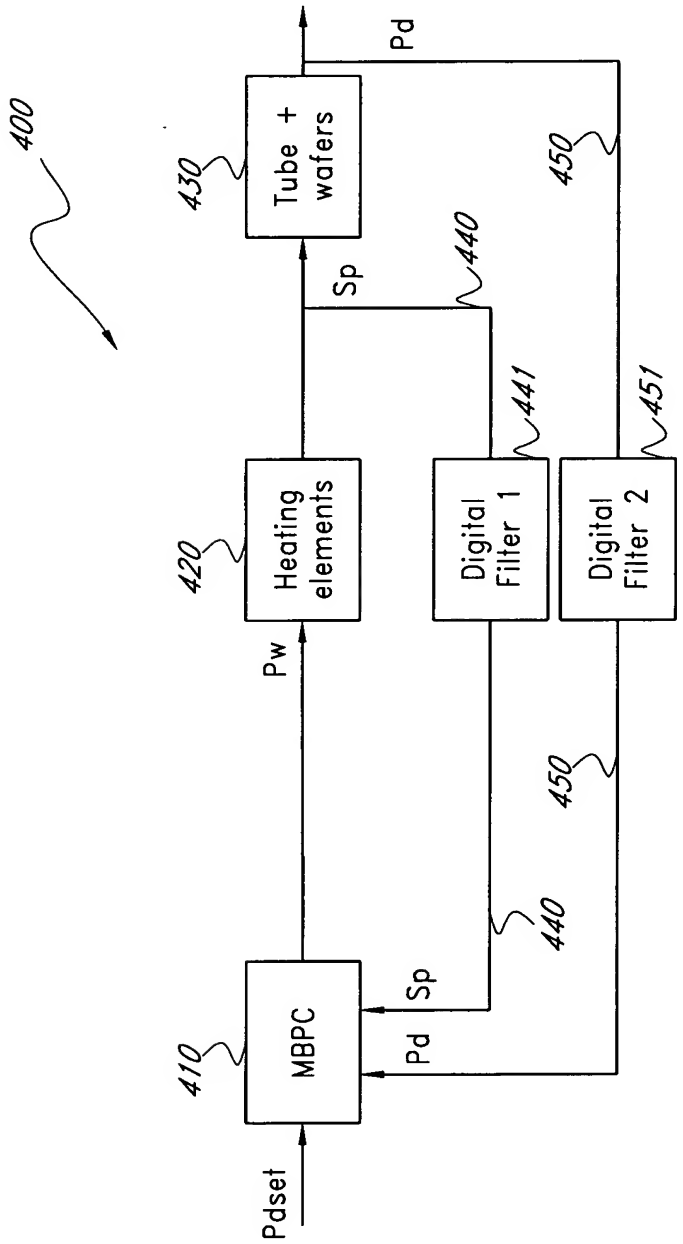


FIG. 4 PRIOR ART

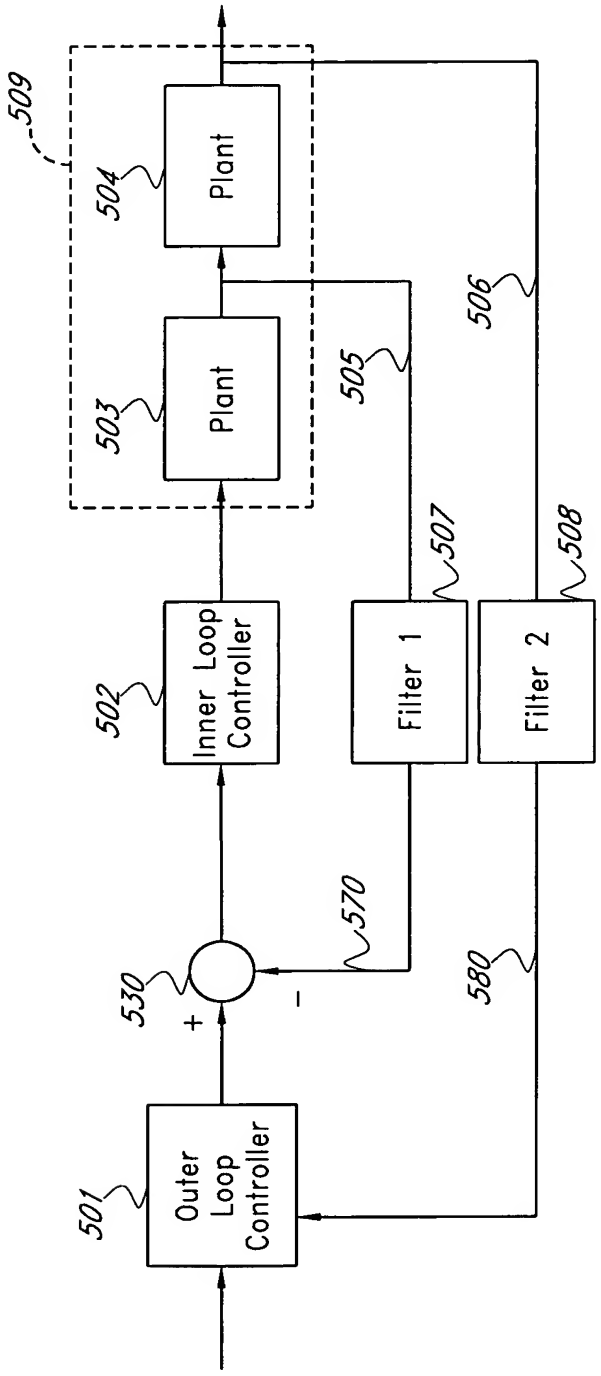

509
504
Plant
503
Plant
505
506
507
508
502
Inner Loop Controller
Filter 1
Filter 2
570
580
530
+
-
501
Outer Loop Controller

FIG. 5A

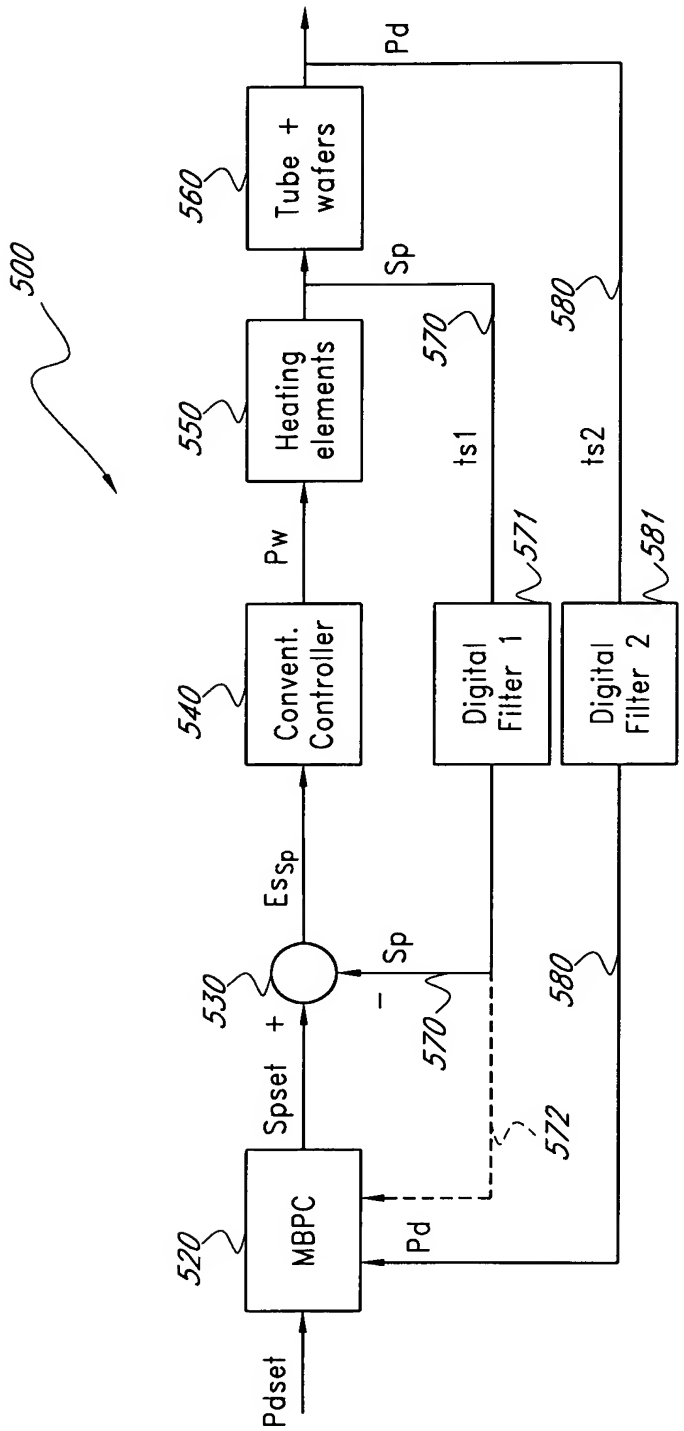

500
Pdset
MBPC
520
Spset
+
530
Es_Sp
Convent. Controller
540
Pw
Heating elements
550
Tube + wafers
560
Pd
Sp
570
ts1
Digital Filter 1
571
572
Pd
Sp
570
580
ts2
Digital Filter 2
581
580

FIG. 5B

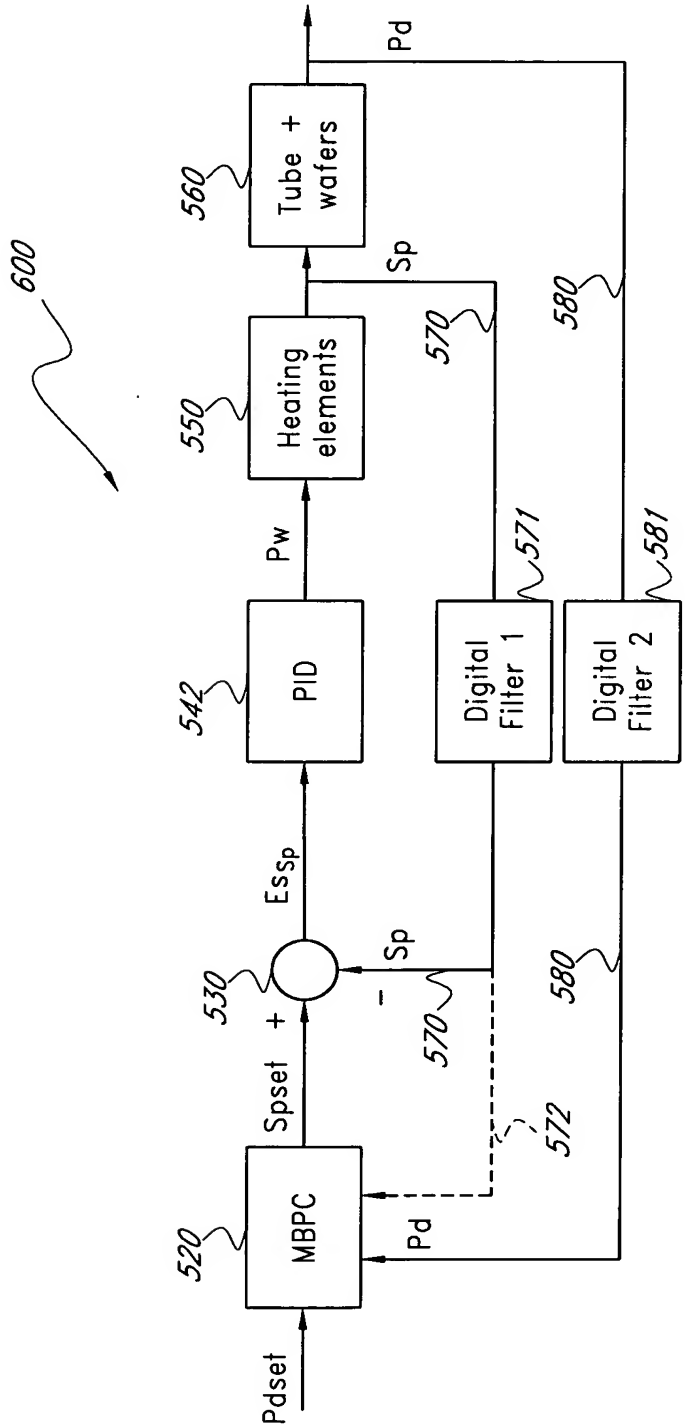
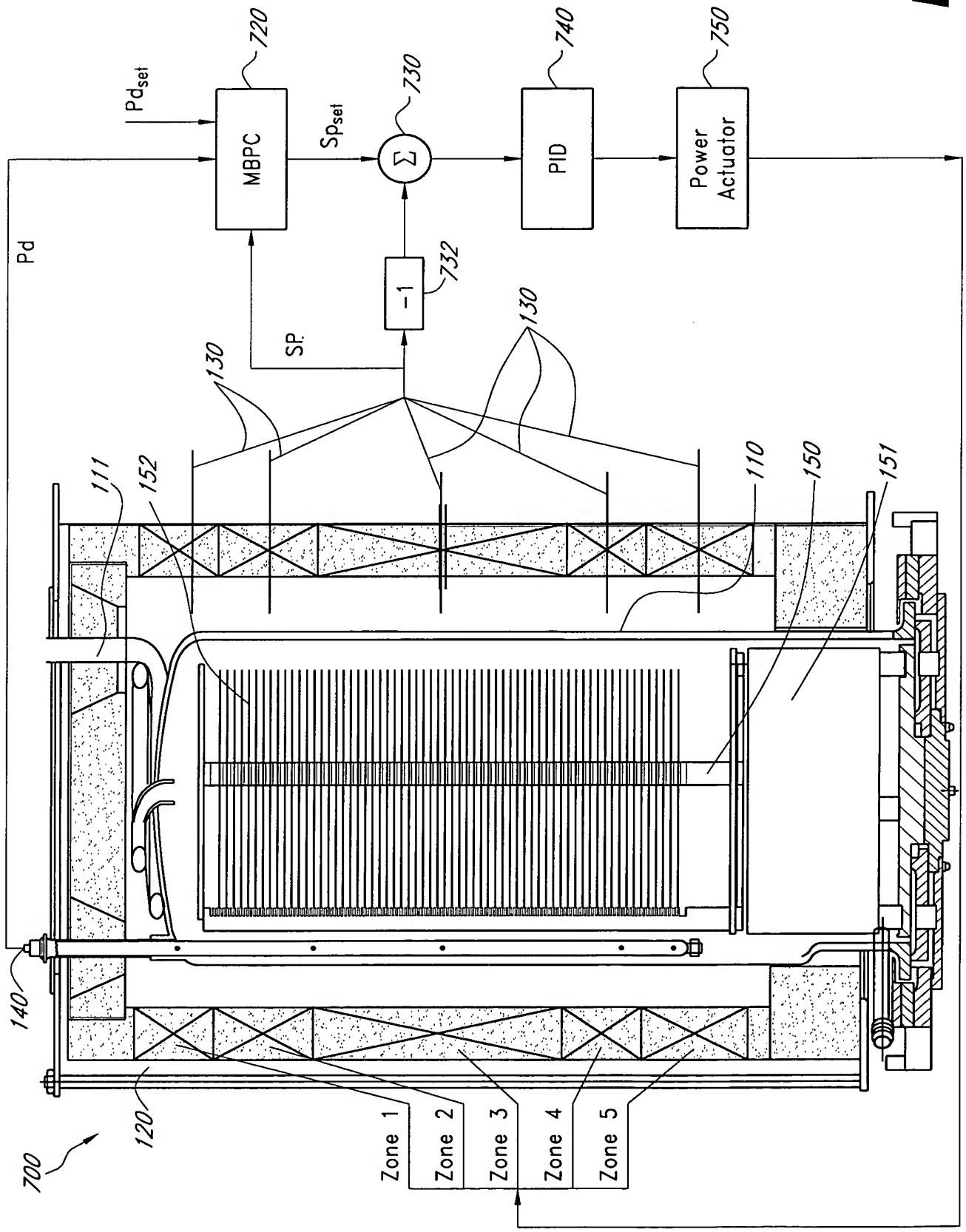

600
Pdset
MBPC
520
Spset
+
530
Ess_Sp
PID
542
Pw
Heating elements
550
Tube + wafers
560
Pd
Sp
570
572
Digital Filter 1
571
Digital Filter 2
581
580

FIG. 6

FIG. 7


720
740
750
730
Pd_{set}
MBPC
Sp_{set}
PID
Power Actuator
Pd
732
-1
SP
130
130
111
152
110
150
151
140
120
700
Zone 1
Zone 2
Zone 3
Zone 4
Zone 5

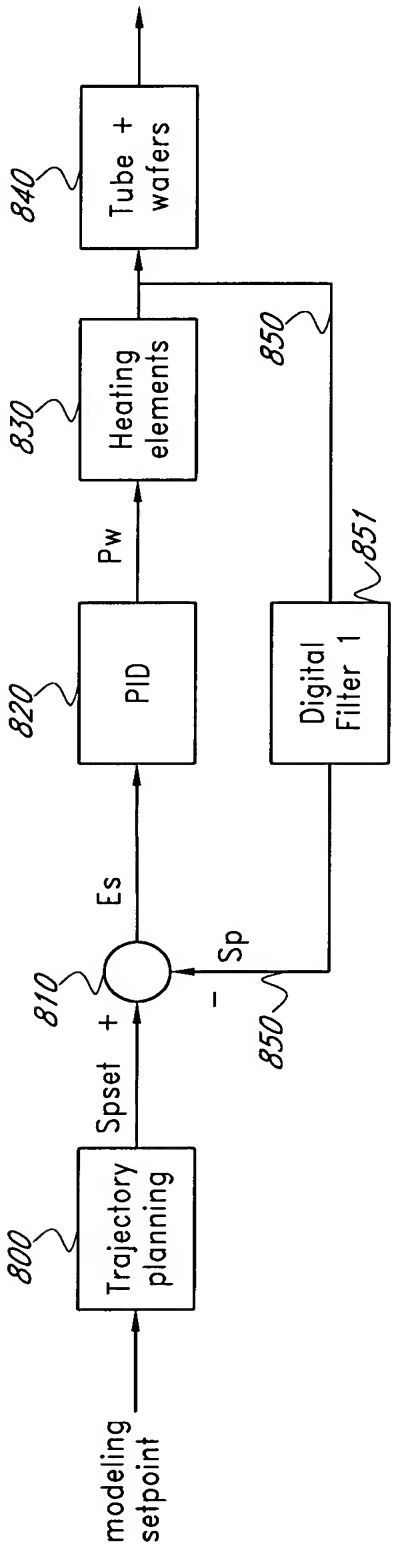

modeling setpoint
800
Trajectory planning
Spset
+
810
Es
820
PID
Pw
830
Heating elements
840
Tube + wafers
850
Sp
-
850
851
Digital Filter 1

FIG. 8

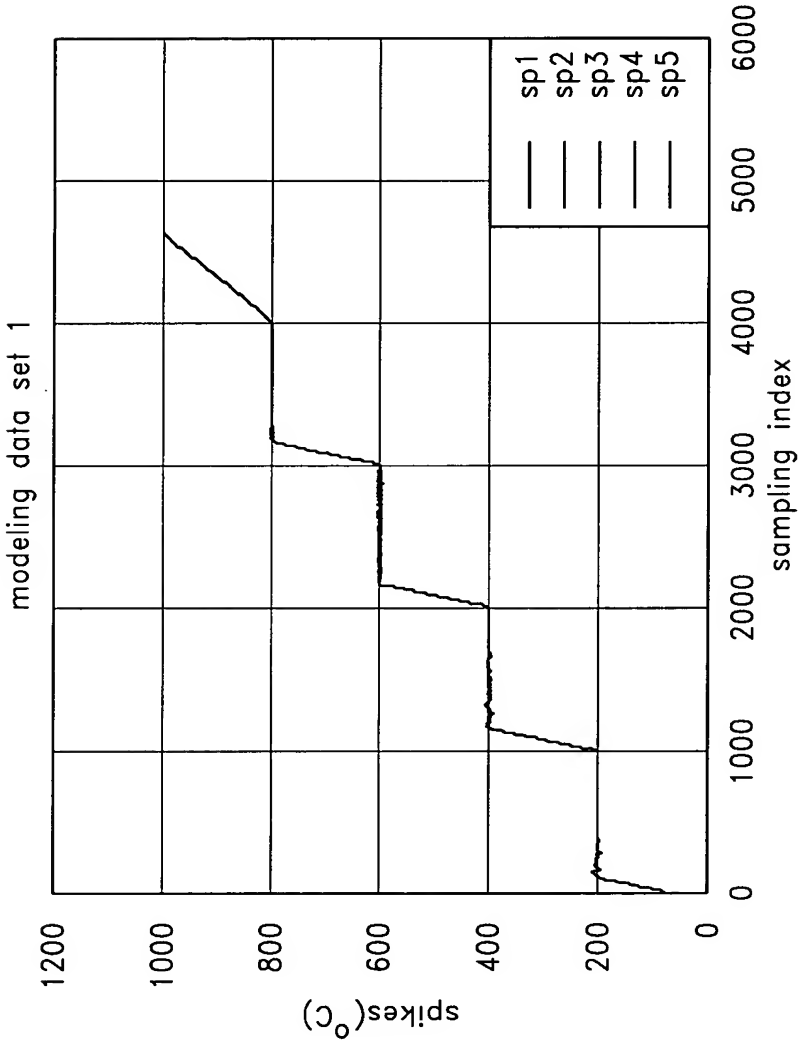

modeling data set 1
spikes(°C)
sampling index
sp1
sp2
sp3
sp4
sp5
0
200
400
600
800
1000
1200
0
1000
2000
3000
4000
5000
6000

FIG. 9

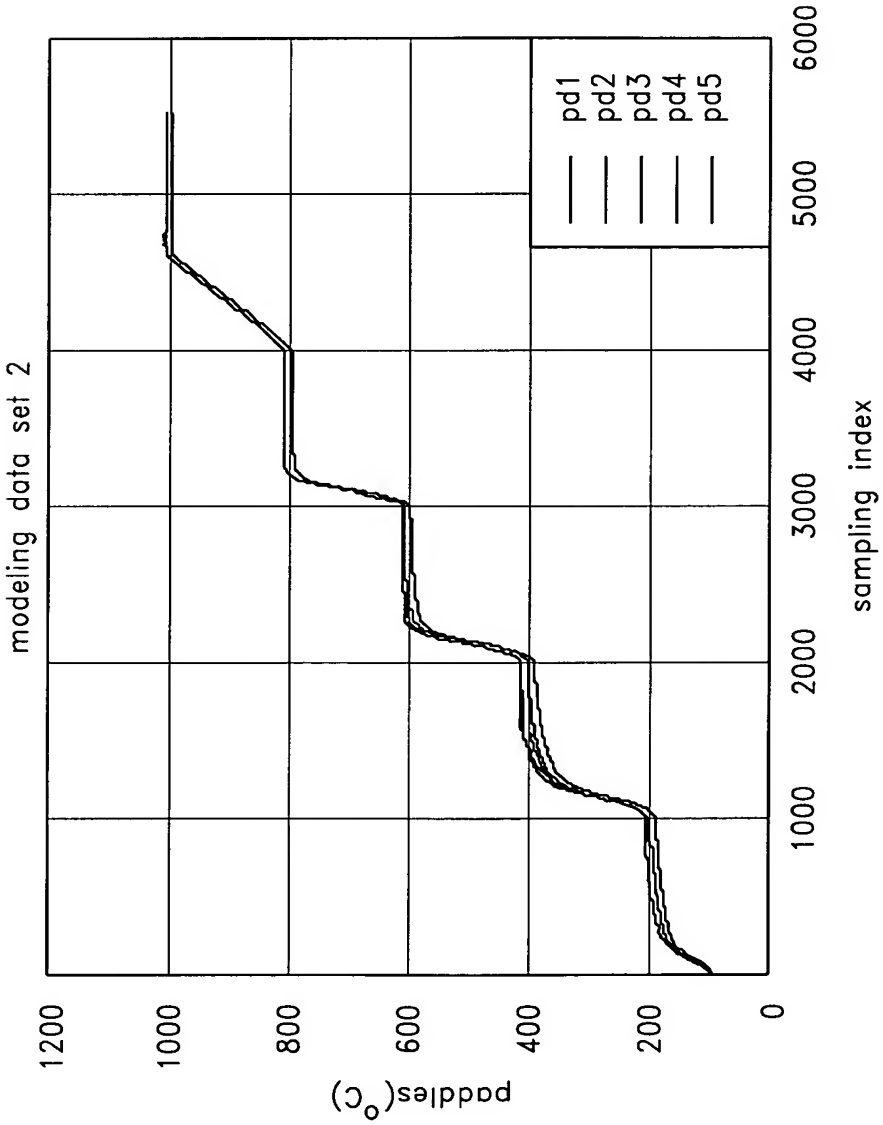

modeling data set 2
paddles(°C)
sampling index
pd1
pd2
pd3
pd4
pd5
0
200
400
600
800
1000
1200
1000
2000
3000
4000
5000
6000

FIG. 10

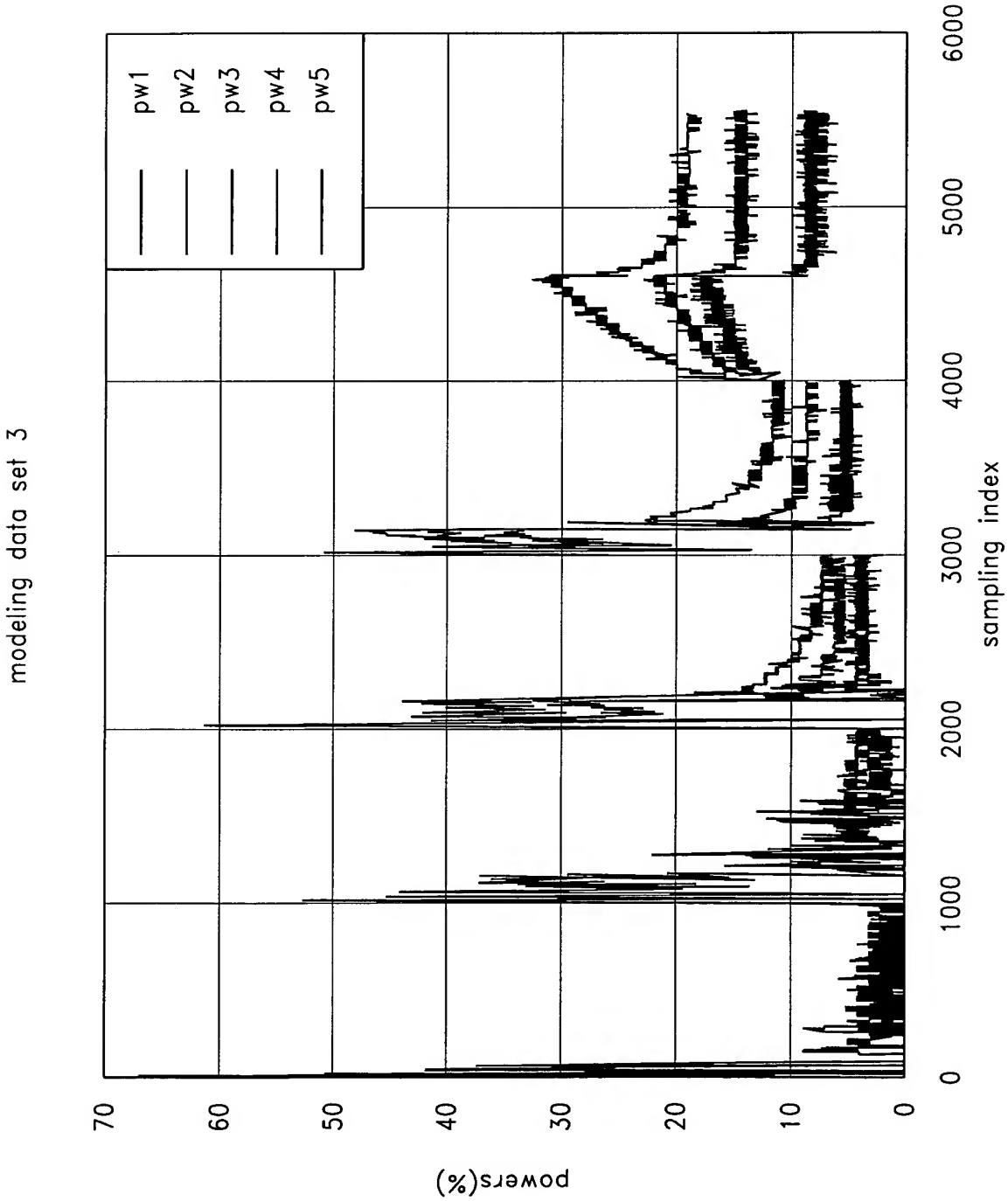

modeling data set 3
pw1
pw2
pw3
pw4
pw5
powers(%)
70
60
50
40
30
20
10
0
0
1000
2000
3000
4000
5000
6000
sampling index

FIG. 11

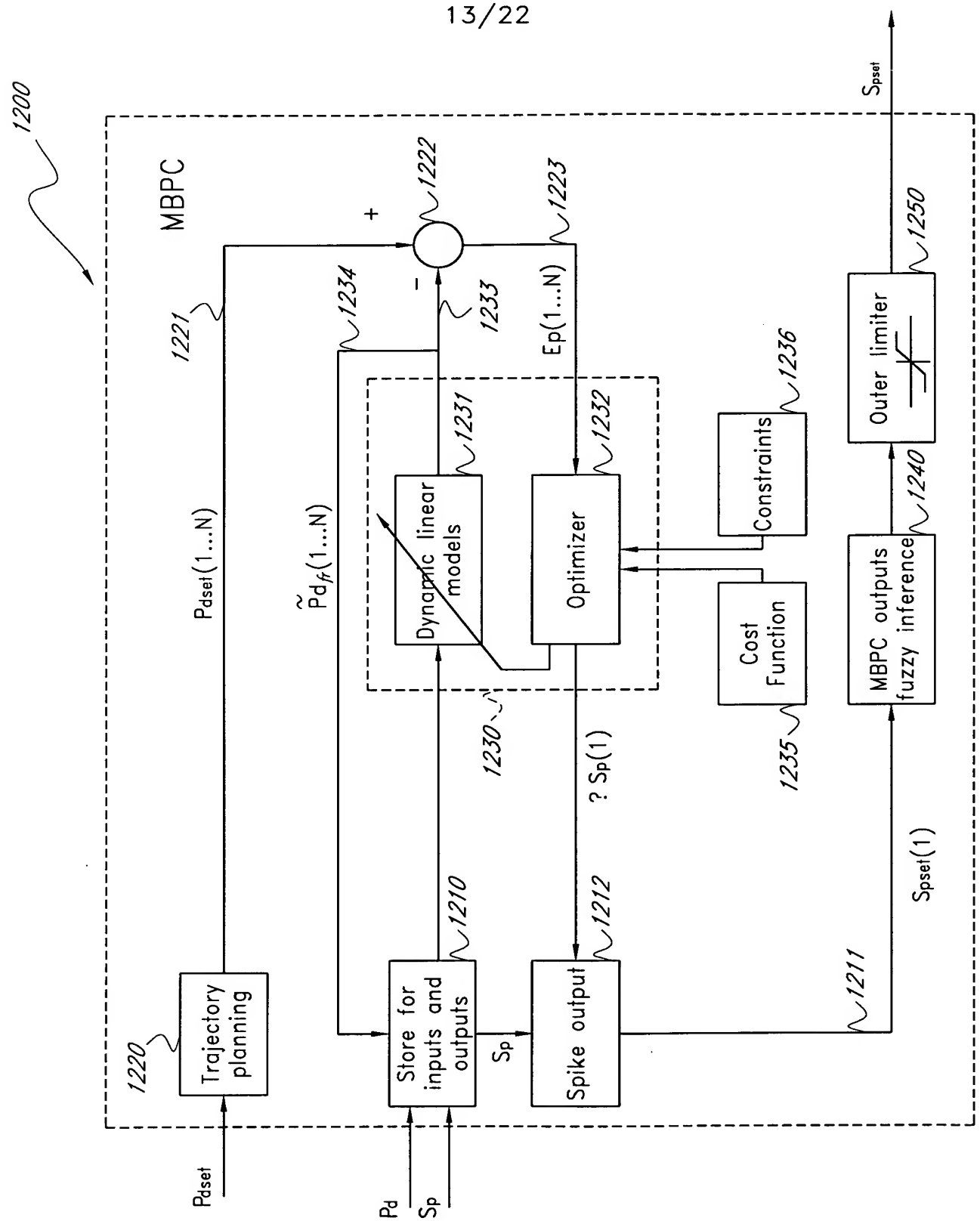

1200
MBPC
1221
1222
1223
1234
1233
Ep(1...N)
1231
1232
1236
Constraints
Outer limiter
1250
1240
Dynamic linear models
Optimizer
MBPC outputs fuzzy inference
Cost Function
1235
1230
? Sp(1)
Pdset(1...N)
Pd_ff(1...N)
Spset
Spset(1)
1210
1212
1211
1220
Trajectory planning
Store for inputs and outputs
Spike output
Sp
Pdset
Pd
Sp

FIG. 12

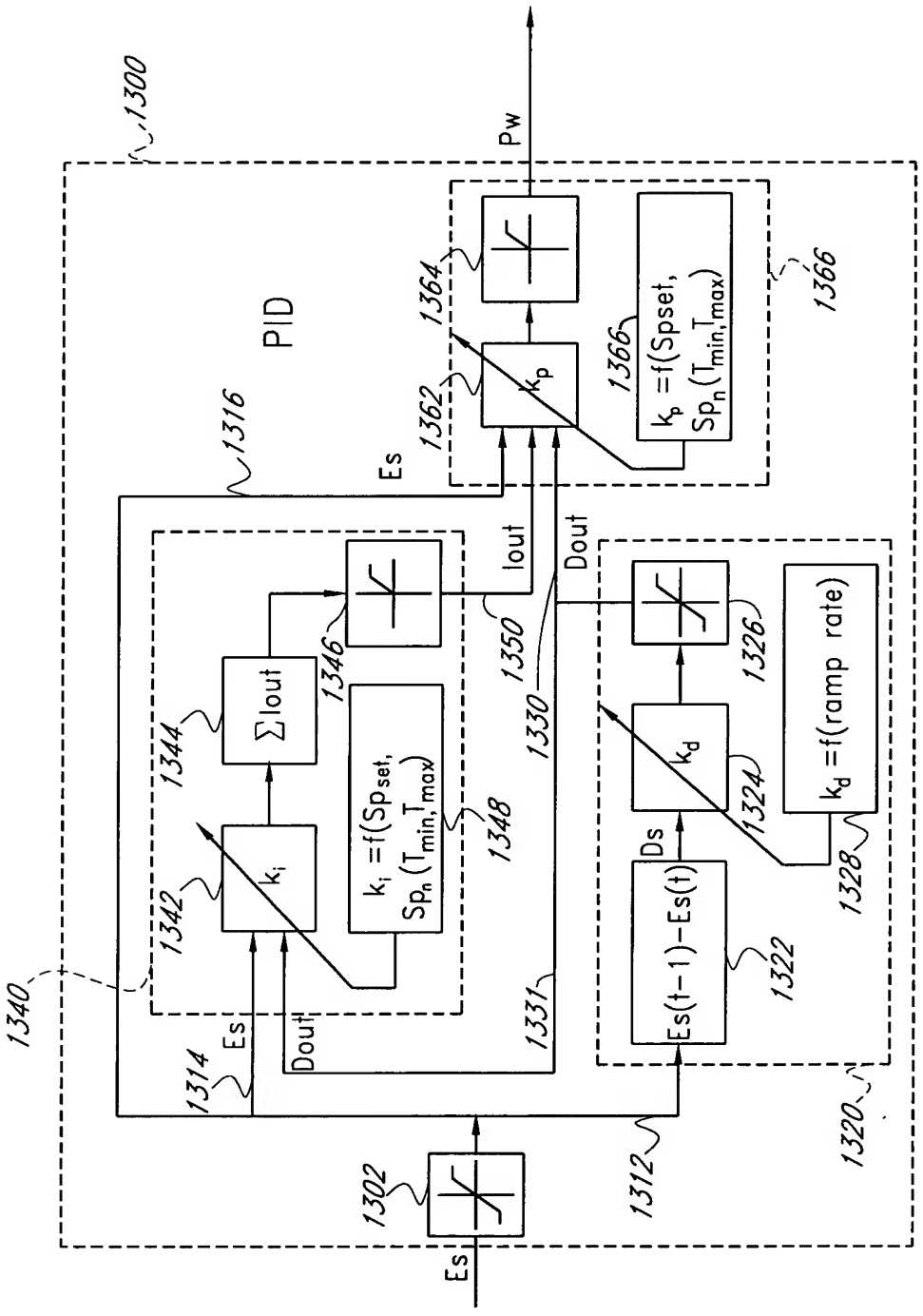

1300
Pw
PID
1316
Es
1364
1362
k_p
k_p =f(Spset, Sp_n(T_{min},T_{max})
1366
1366
1340
1344
$\sum$Iout
1346
k_i
k_i =f(Sp_{set}, Sp_n(T_{min},T_{max})
1348
1342
Iout
Dout
1350
1330
1331
1326
k_d
1324
k_d =f(ramp rate)
1328
Ds
Es(t-1)-Es(t)
1322
1314
Es
Dout
1312
1320
1302
Es

FIG. 13

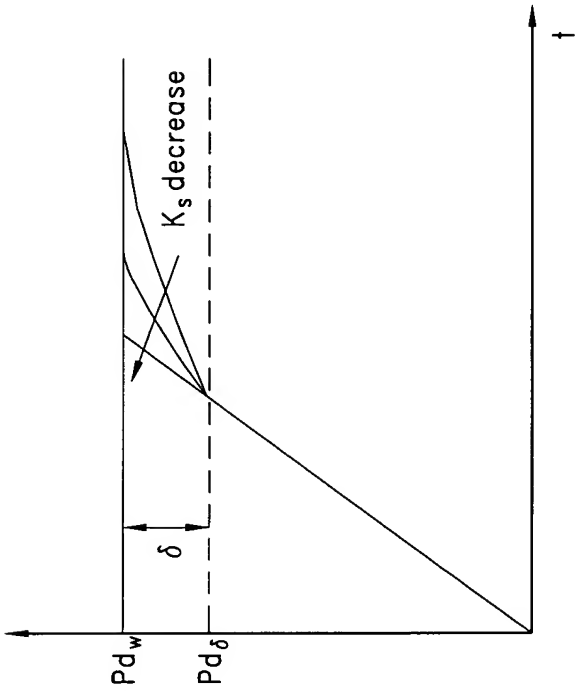


FIG. 14

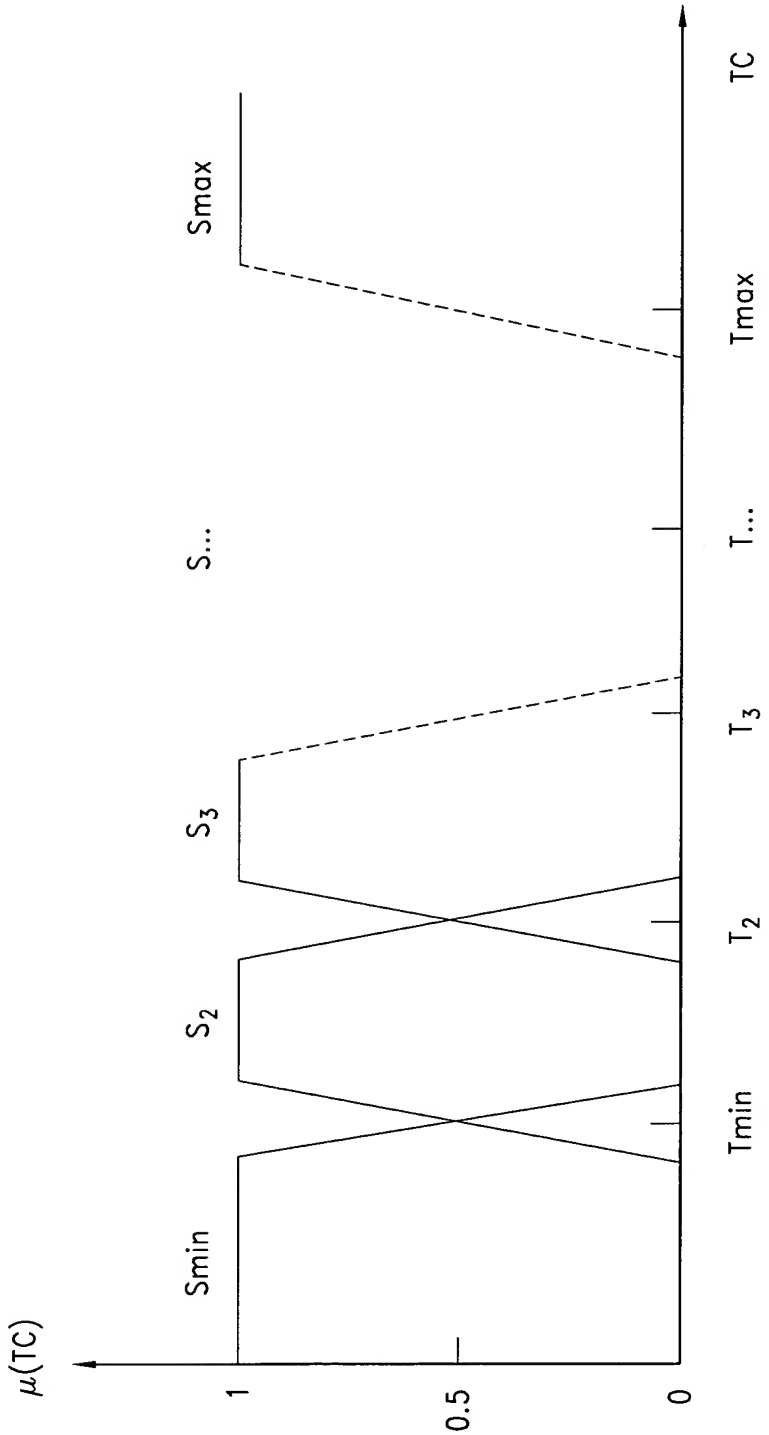


FIG. 15

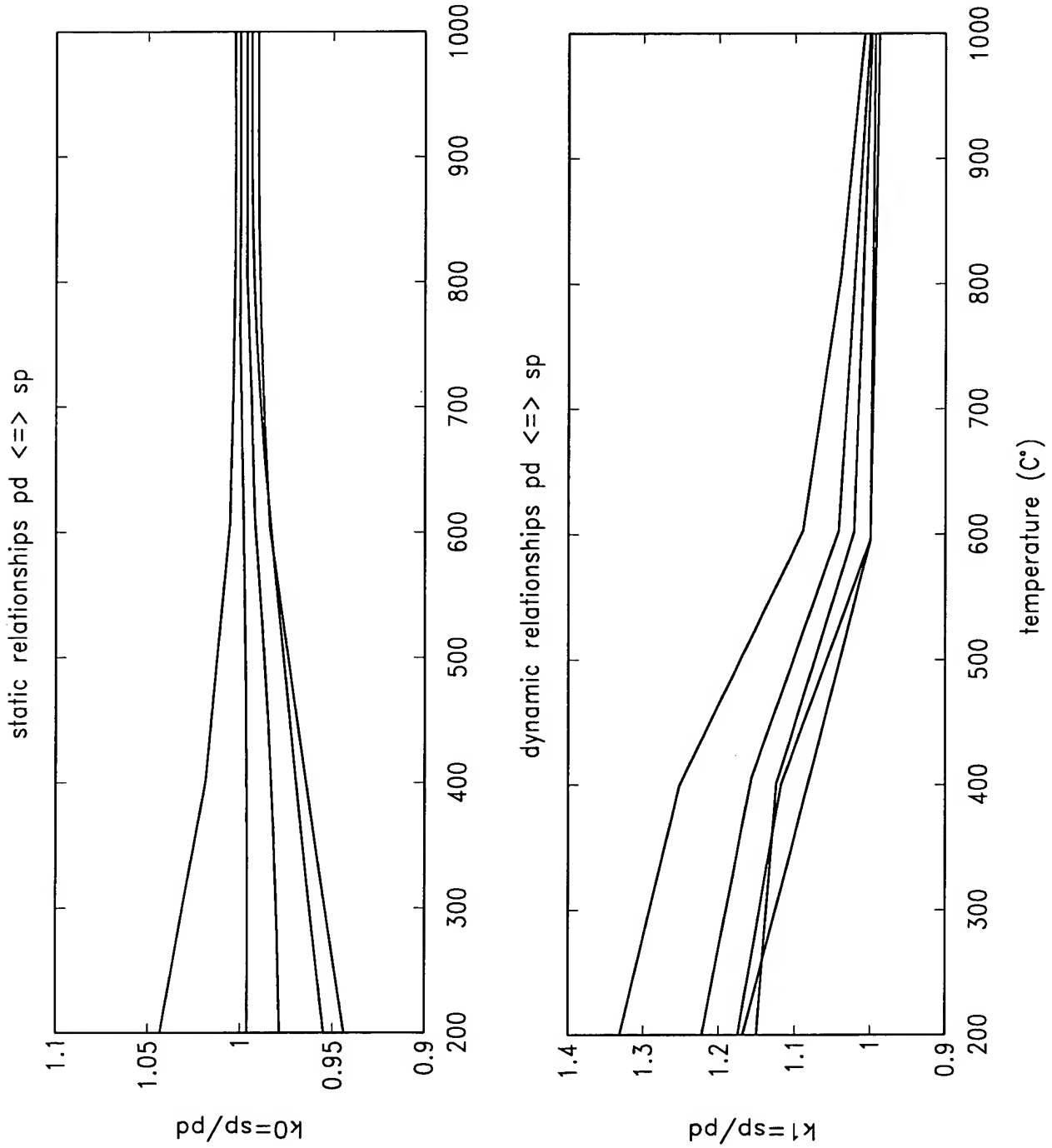

static relationships pd <=> sp
k0=sp/pd
1.1
1.05
1
0.95
0.9
200
300
400
500
600
700
800
900
1000
dynamic relationships pd <=> sp
k1=sp/pd
1.4
1.3
1.2
1.1
1
0.9
temperature (C°)

FIG. 16

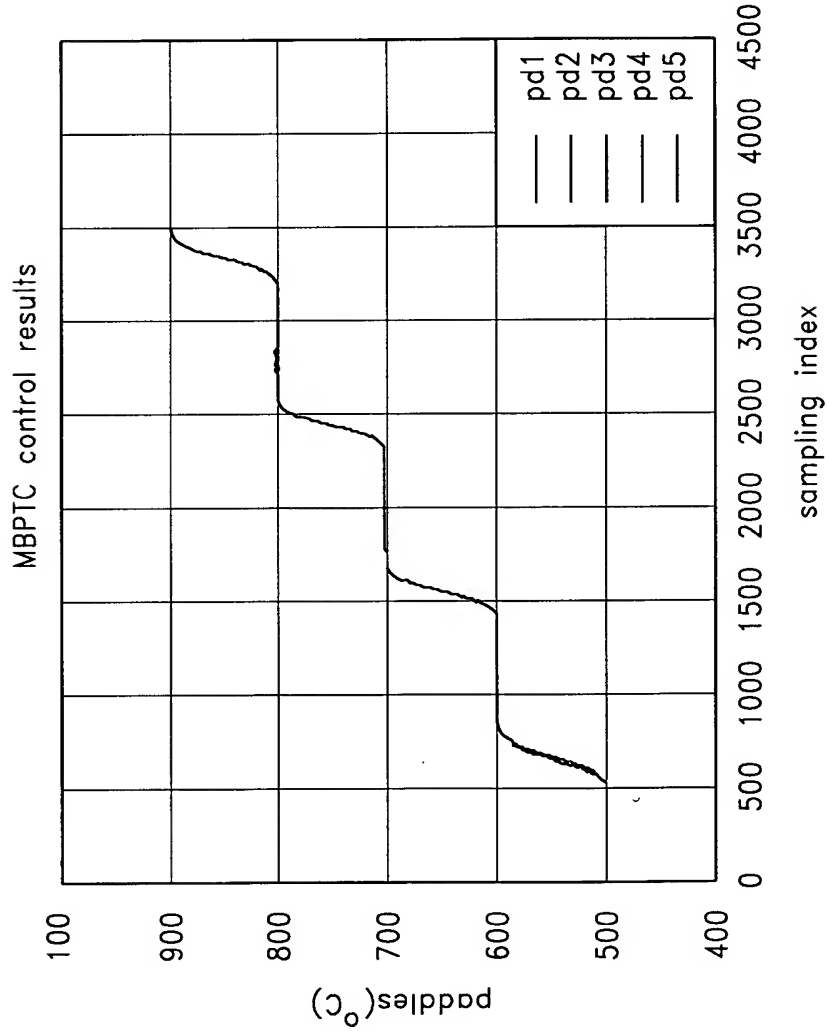

MBPTC control results
paddles(°C)
sampling index
pd1
pd2
pd3
pd4
pd5
100
900
800
700
600
500
400
0
500
1000
1500
2000
2500
3000
3500
4000
4500

FIG. 17

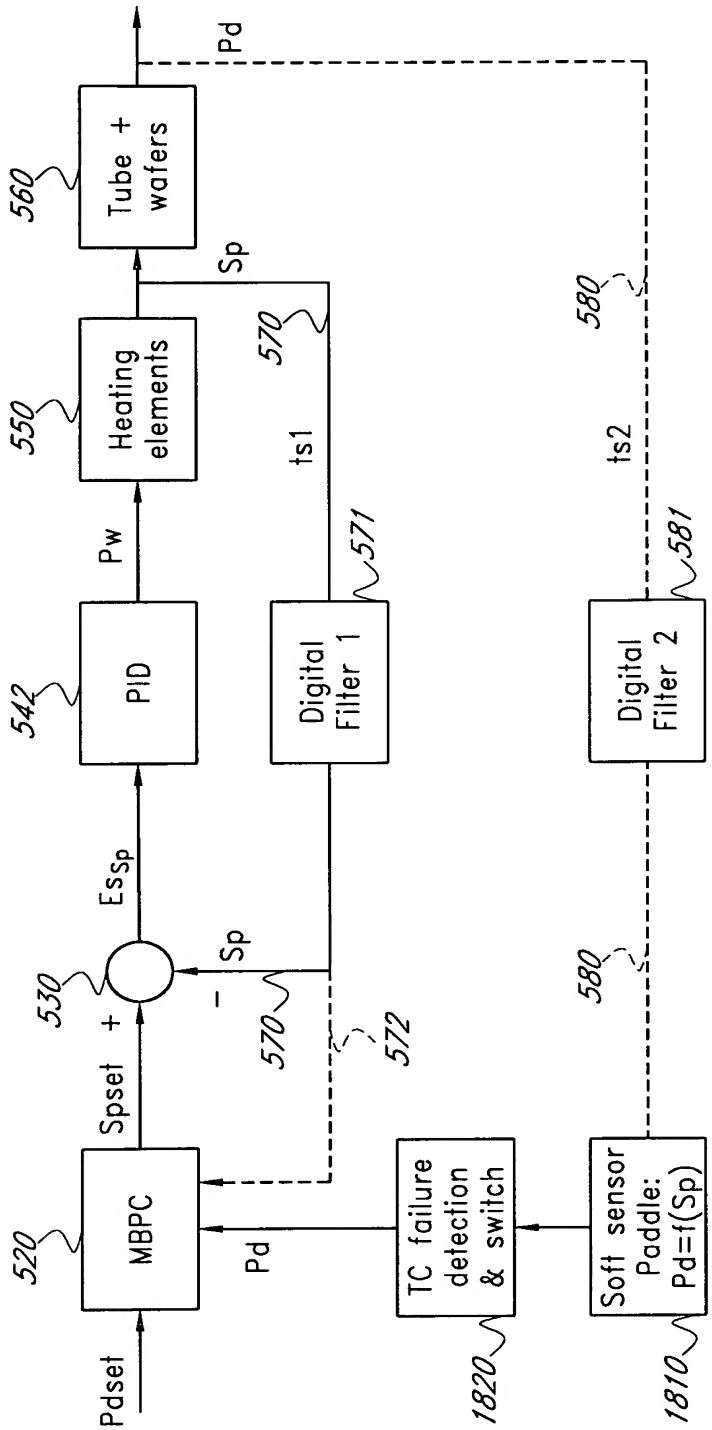

Pd
560
Tube + wafers
Sp
580
570
550
Heating elements
ts1
ts2
Pw
571
581
542
PID
Digital Filter 1
Digital Filter 2
Essp
530
Sp
580
+
-
570
572
Spset
520
MBPC
Pd
TC failure detection & switch
Soft sensor Paddle: Pd=f(Sp)
Pdset
1820
1810

FIG. 18

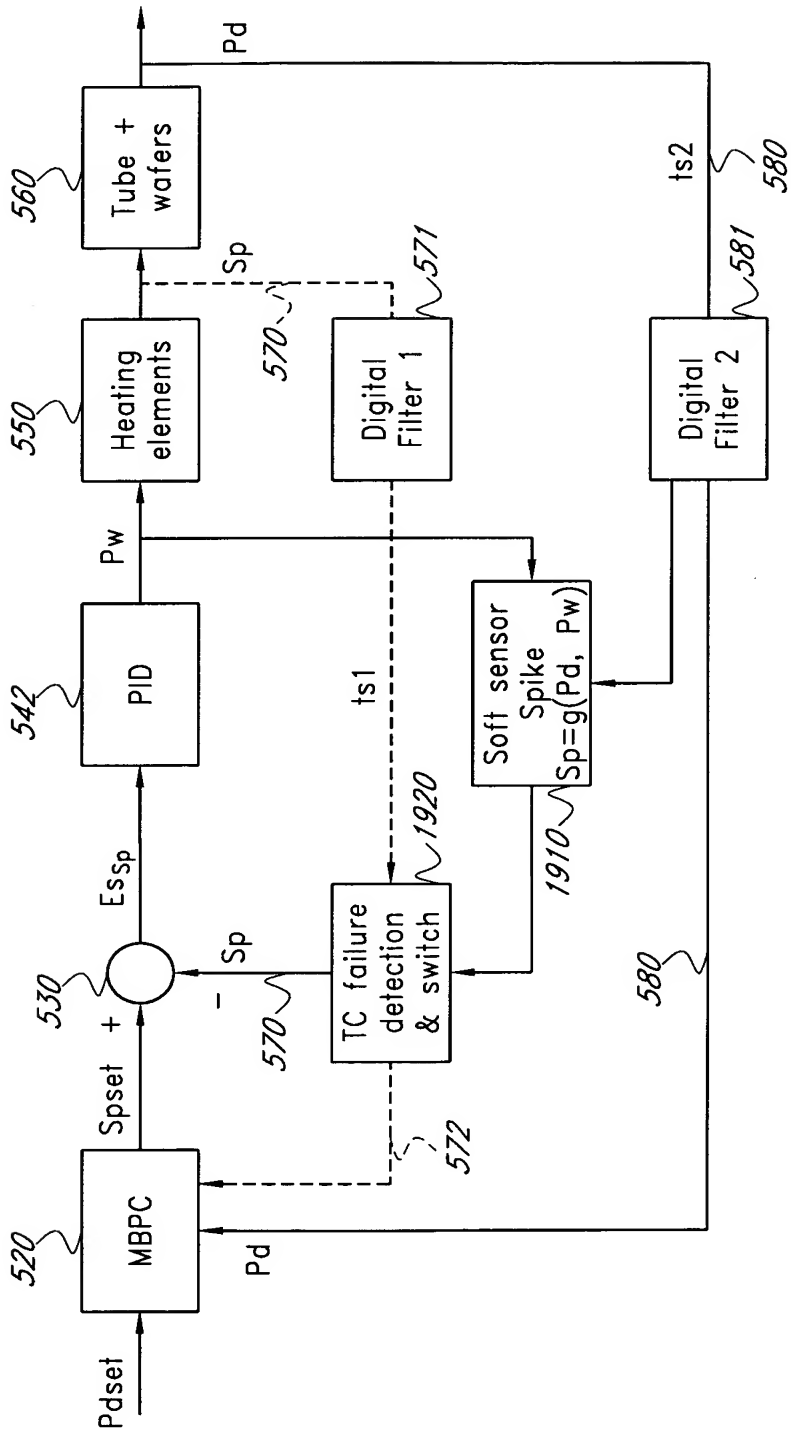

Pdset
MBPC
520
Spset
+
530
Ess
PID
542
Pw
Heating elements
550
Tube + wafers
560
Pd
Sp
570
TC failure detection & switch
572
Sp
570
Digital Filter 1
571
ts1
1920
Soft sensor Spike Sp=g(Pd, Pw)
1910
Digital Filter 2
581
ts2
580
580
Pd

FIG. 19

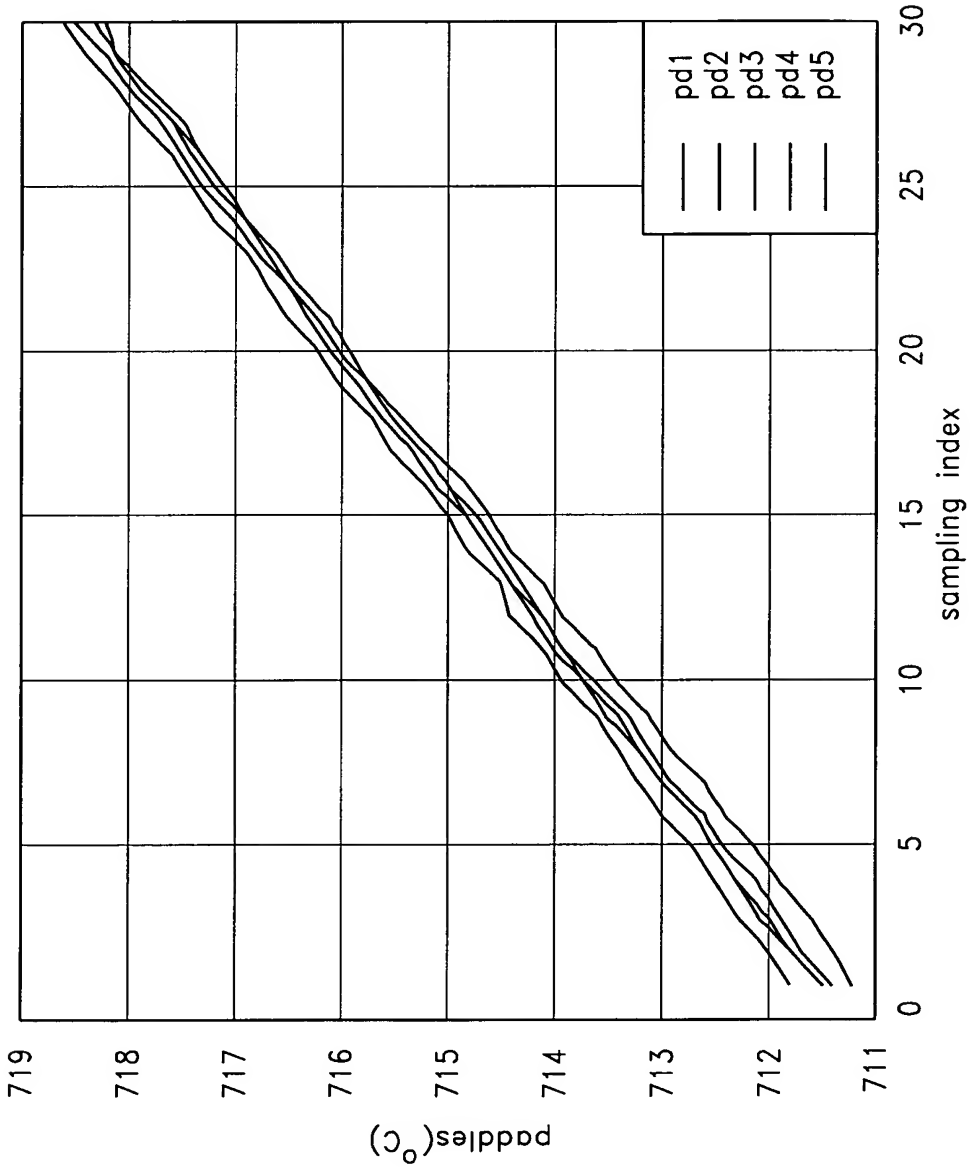

pd1
pd2
pd3
pd4
pd5
719
718
717
716
715
714
713
712
711
paddles(°C)
0
5
10
15
20
25
30
sampling index

FIG. 20

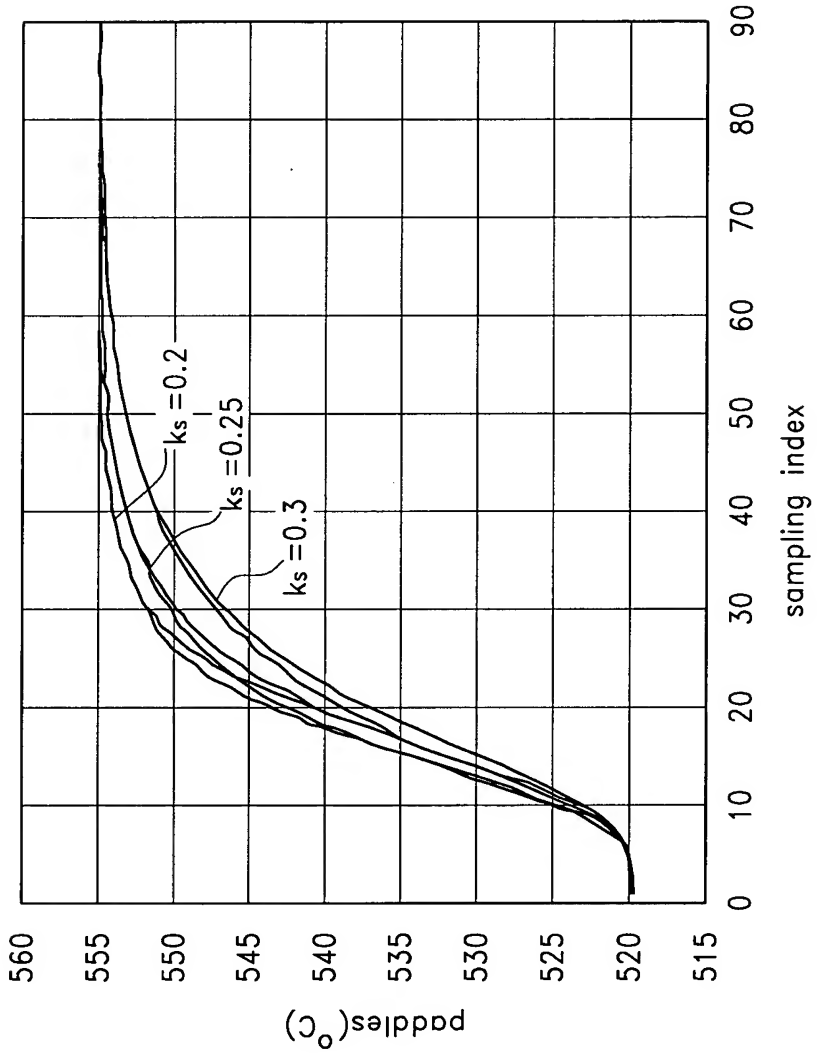

paddles(°C)
560
555
550
545
540
535
530
525
520
515
sampling index
0
10
20
30
40
50
60
70
80
90
ks =0.2
ks =0.25
ks =0.3

FIG. 21